NASA TECH BRIEF
Ames Research Center

Reliability Analysis Based on Operational Success Criteria

The analysis of reliability is an important aspect of aerospace design, and a number of methods are currently employed to obtain estimates of the probable success of space missions. As a rule, the commonly performed reliability analyses include: (1) reliability estimates; (2) failure mode effects and criticality analyses.

These analyses are usually performed independently at various stages of design development and do not result in quantitative visibility of design reliability as a function of design operation versus failure modes; the resulting reliability estimates utilizing existing reliability analysis methods, do not consider that certain failures are irrelevant to mission success. Therefore, it was necessary to establish for a Jupiter mission a specific definition of mission success so that the resulting reliability analysis would be a more accurate presentation of design reliability. The overall result was a more informed basis for making design decisions to optimize reliability. The techniques developed during a study of the reliability analysis for the Jupiter mission are applicable to any commercial design, and they can be extended into software or management systems as required to identify probability of success or required corrective actions.

The baseline reliability prediction is the beginning point in the construction of a system reliability model. It is simply the calculation of overall system reliability based on the assumption that all elements are a reliability series, that is, any component failure is considered catastrophic to mission success. This of course is rarely true in any real life situation, and thus the model predicts only to a first approximation the system's true reliability.

For a more accurate prediction of the system's true reliability, there needs to be examined a Failure Modes, Effects, and Criticality Analysis Model, which disregards the failures of insignificant components. Certain assumptions are used to establish the baselines for the reliability prediction and the analytical method, among which are: (1) constant failure rate as an exponential formula, (2) component type and quantity, (3) basic failure rates taken from actual experience with components, (4) no-failure rate for the critical component on which the mission is predicated (e.g., an infrared detector), (5) an experience factor for orbital reliability, i.e., ratio of actual failures in orbit to expected failures in orbit.

Note:

Requests for additional information may be directed to:

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Reference: TSP 72-10214

Patent status:

No patent action is contemplated by NASA.

Source: F. G. Esmond and M. D. Johnson of
Santa Barbara Research Center
under contract to
Ames Research Center
(ARC-10490)

Category 09